

Chemistry 1506: Allied Health Chemistry 2

Section 5: Carboxylic Acids and Esters

Functional Groups with Single & Double Bonds to Oxygen

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Section 5.1 Introduction, Nomenclature, and Properties

- ❖ Generic Structure of **Carboxylic Acid** and Carboxylic Acid **Derivatives**

- ❖ Members of this Class

- ❖ **Carboxylic Acids**

- ❖ **Esters**

❖ Acid Chlorides

❖ Anhydrides

❖ Amides

- ❖ Physical Properties
 - ❖ Mp and Bp
 - ❖ taste and “feel”
 - ❖ Hydrogen Bonding
 - ❖ H-bond Donors
 - ❖ O-H and N-H
 - ❖ H-bond Acceptors
 - ❖ Lone pairs of O, N, and S

- ❖ Directionally Specific
 - ❖ Hydrogen Bonds and Covalent Bonds

❖ Relative Strengths of Intermolecular Bonds

❖ Van der Waals <

❖ Dipole - Dipole <

❖ Hydrogen Bonds <

❖ Covalent Bonds \approx Ionic Bonds

❖ Hydrogen Bonded Dimers of Carboxylic Acids

❖ Apparent Doubling of MW

❖ Cf. DNA

❖ IUPAC Nomenclature of Carboxylic Acids

❖ anoic acid (two words)

❖ Examples

Section 5.2 Important Carboxylic Acids

- ❖ Formic Acid (Methanoic Acid)

- ❖ Ants

- ❖ Acetic Acid (Ethanoic Acid)

- ❖ Vinegar

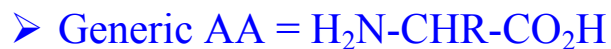
- ❖ Oxalic Acid (dicarboxylic acid)

- ❖ Rhubarb, Spinach, etc.

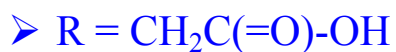
- ❖ Benzoic Acid

Section 5.3 Amino Acids having Carboxylic Acid Containing Side Chains

➤ Amino Acids (Building Blocks of Proteins)



➤ Aspartic Acid (acidic)



➤ Glutamic Acid (acidic)



Section 5.4 Biological Carboxylic Acids

➤ Fatty Acids

➤ $R-CO_2H$

Section 5.5 Preparation of Carboxylic Acids

❖ Oxidation Reactions

❖ Oxidation of Aldehydes (Strong)

❖ Oxidation of 1° Alcohols (Strong)

Section 5.6 Acid/Base Chemistry

- ❖ Equilibrium of Carboxylic Acids and Water
 - ❖ Effects of the Electronegativity of R

- ❖ Carboxylic Acids plus Bases
 - ❖ Base = OH⁻, CO₃⁻², HCO₃⁻, NR₃, Pyridine, etc.

❖ **Nomenclature of Carboxylate Salts**

❖ Metal Alkanoate

❖ Examples

❖ **Carboxylate Salts plus Acids**

❖ HCl , H_2SO_4 , etc.

Section 5.7 Esters

- ❖ Generic Structure

- ❖ Partial Charges on Carbon (δ^+) and Oxygen (δ^-)
- ❖ No Hydrogen-bonding with self
- ❖ H-bonding acceptor

- ❖ Physical Properties

 - ❖ Mp and Bp

 - ❖ Cf. Carboxylic Acids

 - ❖ odor

❖ Ethyl Acetate (Ethyl Ethanoate)

❖ IUPAC Nomenclature

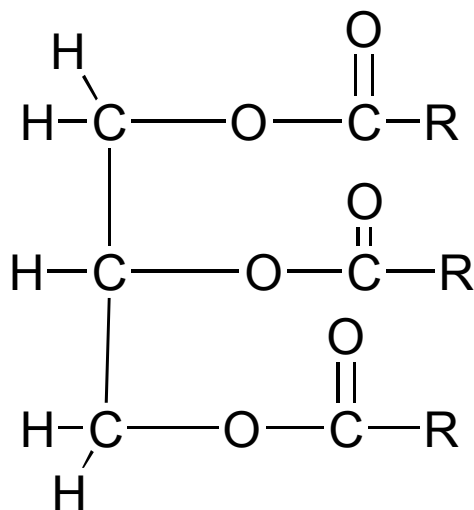
❖ Alkyl Alkanoate

❖ Examples

Section 5.8 Biological Esters

➤ Triglycerides

➤ Glycerol and Fatty Acids



Section 5.9 Ester Synthesis and Hydrolysis

- ❖ Direct Esterification

- ❖ Uses H^+ catalyst

- ❖ Direct Hydrolysis

- ❖ Uses H_3O^+ (i.e., $\text{H}^+/\text{H}_2\text{O}$)

- ❖ Indirect Esterification (easier)
 - ❖ Via Acid Chlorides (Thionyl Chloride, SOCl_2)
and Alcohols

- ❖ Alkanoyl Chlorides

Section 5.10 Phosphorous Acids and Esters

- ❖ H_3PO_4 neutralization
- ❖ Stepwise addition of OH^-

- ❖ H_3PO_4 alkylation

- ❖ Addition of one equivalent of Alcohol

- ❖ Cf. Carboxylic Acid reactions

- ❖ Enzyme catalyzed gives monoalkyl phosphates

- ❖ Diesters and Triesters

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